this matter, I shall content myself now with mentioning one result of my inquiry, which I consider as well established; the result, in fact, of performing on muscles the same kind of experiment as the one above described on the organ of the Torpedo. The experiment is as follows:—Having selected a series of muscles, entire or divided, which have been proved (by my method of opposed muscular piles) to be equal in electromotive power; subject a certain number of them to repeated stimulation, and then, by means of the method of opposed couples, compare the muscles which have been exercised with those which have been left at rest, and it will be found that the latter will manifest a much greater degree of electromotive power than the former. The nervous excitation, which causes muscular contraction, developes heat, generates mechanical force and consumes chemical affinity; and as the electromotive apparatus of muscle operates through means of that affinity, it must get weakened, like a pile in which the acid has become weaker. In the Torpedo, on the other hand, there is neither heat nor mechanical force produced, and the electromotive apparatus is set up again, as it were, through the influence of the nerves, after the manner of a secondary pile."

V. "Natural History of the Purple of the Ancients." By M. Lacaze Duthiers, Professor of Zoology in the Faculty of Sciences of Lille. Communicated by Professor Huxley. Received March 22, 1860*.

The purple dye so esteemed by the ancients has by turns excited the curiosity of naturalists and of historians. The number of memoirs upon the subject is considerable, and they are to be found in almost all tongues. However, in all these works, remarkable in many respects, and which cannot be analysed in this short notice, three deficiencies are to be noted regarding matters of very great moment in the history of this substance.

What are, 1st, the producing organs? 2ndly, the nature? 3rdly, the natural primitive colour of the dye? It is difficult to give any answer to these three questions by means of the facts contained in existing memoirs. It is for the purpose of replying to them that I

* Translation received August 22, 1860.

have undertaken the investigation, whose chief results I have the honour now to lay before the scientific world.

The two genera *Murex* and *Purpura* have yielded the species observed. In very distant localities, as at Mahon in Minorca, *Murex brandaris*, *M. trunculus*, and *Purpura hæmastoma* have furnished results which observations conducted at Boulogne on *Purpura lapillus*, at Pornic (Vendée) on the same species and *Murex erinaceus*, and at La Rochelle and L'Ile de Rhé, have confirmed. At Marseilles, *Murex brandaris* has yielded altogether similar results; and this concordance of all the observations permits me to offer them with much confidence.

What is the organ which produces the dye?

The analogy which some chemists imagine they have found between the colour of alloxan or of murexide and the purple of the Mollusca, has led them to misconceive the nature of the organ which produces the colouring matter. It is indubitable that uric acid treated with nitric acid gives a beautiful reddish purple colour when the residue is exposed to ammoniacal vapour; and this reaction furnishes a means of detecting the renal organ in mollusks. But from this circumstance no one could be justified in concluding that the purple dye was either the secretion of the kidney or the result of a modification of the urine.

Careful dissection of the purpuriferous mollusca proves that the purple dye is secreted by a very limited portion of the mantle, which can in no way be confounded with the true renal organ, as which the organ of Bojanus is now generally regarded; the position and the structure of the purpuriferous organ are indeed totally different from those of the kidney.

Small in extent, this part occupies very nearly the space bounded by the branchiæ and the rectum, beyond whose extremities it hardly extends anteriorly, while posteriorly it, at most, reaches the organ of Bojanus. It forms neither a sac nor a reservoir, as it has been stated to do; and these phrases, as well as 'purpuriferous vein,' should be rejected, because the organ is simply extended over the surface.

Large elongated cells, placed perpendicularly side by side on the surface of the pallial cavity in the direction of its greatest diameter, compose its tissue. They form about two or three layers, the most

exterior of which, covered with vibratile cilia, presents the most developed cells. Below lies a very rich capillary network, which distributes the blood coming from the organ of Bojanus and the neighbouring parts of the mantle to the branchiæ. The cells, when they have reached maturity, fall into the pallial cavity, become endosmotically distended, burst, and mingle their contents with the other mucus which already existed there. This independent and isolated shedding of the histological elements constitutes the secretion of the dye-stuff, which, it is obvious, is not produced by a compound gland, or indeed by any gland in the proper sense of the word, but by a glandular portion of the pallial surface. It is the granular but soluble matter contained in these cells which possesses singular properties, and constitutes the dye-stuff.

The peculiar layer whose position has just been indicated is not special, anatomically speaking, to the two genera *Murex* and *Purpura*; and this is important if, in looking at the matter morphologically, a similar part of the surface of the mantle of most gasteropods appears to produce a substance of like histological character, but different in its properties. In the Aplysiæ and the Snails it is naturally coloured, whilst in *Turbo littoralis* and *Trochus cinereus* it is colourless, and undergoes no modification by the action of the solar rays.

Thus, then, it is incorrect to say, with some chemists, that, anatomically speaking, the purple dye-stuff is yielded by the kidneys of *Mollusca*.

Anatomical investigation has led to the recognition in the genera *Murex* and *Purpura* of a peculiar anal gland placed alongside the rectum, and opening by a terminal pore close to the anus. This gland, which does not seem to have been described hitherto, is in structure and the arborescent disposition of its secretory cæca, a well-defined gland; and by this very circumstance it is impossible to confound it with the purpuriferous organ.

Properties of the Purple Dye-stuff.—A very curious fact, known from all antiquity, since the very existence of the dye depends upon it, is the transformation of the dye-stuff by the action of the solar rays. In the living animal this substance is at first colourless, or more or less yellowish; exposed to the light of the sun, in a moist state it acquires a pure violet hue; in a word, it is photogenic.

The solar action causes the three simple colours to be developed successively, and in the following order, yellow, blue, and red. Between these, the compound colours green and violet which result from their mixture, are obtained with the greatest distinctness if the action is slow. But whilst the yellow disappears by prolonged action, a considerable amount of blue always remains; whence in nature the final red is never pure, so that the dye always inclines more or less to violet.

These properties have been placed beyond doubt by the possibility of making photographs on silk and cambric, which exhibit a remarkable delicacy in detail, combined with great strength of tone.

In a photograph obtained in this way, the different tints through which the dye-stuff passes before becoming violet are more or less to be seen, but the deep violet predominates, and represents the black of ordinary photographs.

The changes in the colour of the purple dye-stuff are accompanied by the production of a very penetrating fœtid odour, similar to that of essence of garlic. The evolution of this odour is as characteristic of the solar action as the changes of colour, a consideration of much importance when we desire to solve the problem to which I now turn—*What was the primitive colour of the purple stuffs of antiquity?*

At first sight this question seems to be easily answered; but when one seeks for a precise signification of the word "purple," one soon becomes embarrassed. If we ask a painter, without telling him why,—Be so good as to paint the shade which you would give to a purple drapery in a historical painting—each painter to whom the request is made will give a different colour. This is the case because no one has an exact idea of the primitive colour, which has been gradually modified, and which has now become the red, almost scarlet, which many painters understand by the word purple. It is only by the interpretation of the phrases of the ancients, and comparing them with direct observations, that one arrives at a solution of the difficulty, which would appear to be of great use to art.

It is enough to remark that the purple colour exists only because it has been developed by the sun, in justification of the conclusion that the ancients must have been acquainted with this peculiarity, as also with that of the development of the characteristic fœtid

odour. Pliny, moreover, speaks of both, and hence it cannot be doubted that the purple was produced formerly exactly as at present, unless we admit that the animals and their dye-stuff have changed, which would be an altogether gratuitous hypothesis. The conclusion to which we are driven then is this: the colour was produced formerly as at present, under the same conditions and with the same characters, so that it ought to have been similar to that which we now obtain.

In simple and natural experiments the violet has never failed to appear, while pure red has always been absent. One is led to conclude, therefore, that the natural and unmodified purple of the ancients was violet, as it is now; for whoever discovered it must have made the experiment, as it has been so often repeated, on the sea-shore, by breaking a purpuriferous mollusk, and crushing its mantle on moist linen which is exposed to the sun.

Pliny cites Cornelius Nepos, who states positively that at first the violet purple was esteemed; and the passages of Plato and of Aristotle, which relate to the colour, lead to the same conclusion. However, it cannot be doubted that though the colour of purple stuffs was primitively violet, the requirements of taste and of fashion led to the variation of its shades. Thus some stuffs were dyed twice, to give them a richer and more vivid colour—the so-called 'purpurea dibapha.' The mixture of species also contributed to modify the hues.

Murex trunculus gives an almost blue shade. The fishermen of Port Mahon told me that it always yielded that colour, and especially that it would give a fixed and permanent colour. On the contrary, *Purpura hæmastoma* (which they call 'cor de fel') was known to them as staining their linen very permanently and ineffaceably.

It ought also to be recollected that when mineral colours replaced the animal matter of mollusks, the hue varied; and though the term 'purple' might be retained, it was easy to pass by degrees to the deep red which rises in the mind when we recollect the purple worn by cardinals.

Perhaps also the manipulations to which the molluscan dye-stuff may have been subjected by the dyers, and of whose nature we know nothing, approximated the purple to the red, which Pliny compares to that of coagulated blood.

But it remains none the less demonstrated, both by the passages

from ancient authors and by experiment, that the *primitive and natural colour of the purple was formerly, as now, violet.*

Hence it would appear to be requisite for a painter to consider the epoch when the personages who are represented clothed in purple drapery lived, for the hue varied with the age. The properties of the purple dye-stuff also render intelligible one ground of the esteem in which the colour was held; for, developed by the influence of light, it could not fade, like the red of cochineal for example, but must always have remained beautiful, even in the luminous and dazzling atmosphere of Italy and the East.

It would be difficult, with the scanty materials we possess, to determine exactly the species employed by the ancients. Without doubt Pliny has indicated the two genera *Murex* and *Purpura* of the moderns by the names *Purpura* and *Buccinum.* It is probable that *Murex trunculus* and *brandaris,* and *Purpura hæmastoma,* were employed by the dyers; but it would be difficult to identify the different species indicated by Pliny. Zoological investigations, accompanied by experiments which are all simply and easily made, would perhaps lead to results more definite than can be obtained by the interpretation of passages, if one could carry them out on the shores of countries formerly famous for their purple—those of Tyre for example.

Fig. 1.

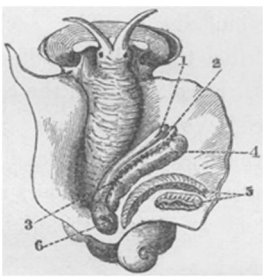

Fig. 2.

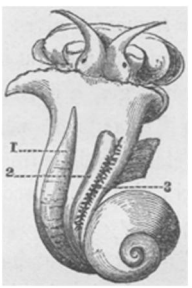

Fig. 1. Animal with *Purpura lapillus,* with the pallial cavity laid open.

1. Genital orifice. 3. Anal gland. 5. Branchiæ.
2. Anus. 4. Purpurogenic organ. 6. Organ of Bojanus.

Fig. 2. The animal simply removed from its shell.

1. Branchiæ. 2. Purpurogenic organ. 3. Anal gland.